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ORGANIZATIONAL FAILURE IN HOSPITALS:

AN ANALYSIS AND A PROPOSAL*

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The hospital presents serious analytical problems for the theory of the firm. Hospitals' profit incentives are dulled by their avowed public service orientation. Equity ownership is absent. The product market is poorly informed and noncompetitive. There are complex administrative interactions with governments, regulatory agencies and insurers. Within hospitals, decision-making power is widely diffused among independent physician professionals. Under these conditions, it is difficult to maintain the neoclassical view of the firm as a single decision-maker, maximizing a well-defined objective function and operating as a self-contained entity in a market environment. The ad hoc adjustment of the hospital's maximands to conform to observed behavior would be dubious if not tautological. The hospital should be distinguished from the conventional firm not by the peculiarities of its motives, but by those institutional conditions which constrain its "rational" behavior.

This essay proposes an alternative theory of the hospital which directly addresses these institutional constraints. Because these constraints do not all operate externally through the market, this approach requires explicit consideration of the firm's internal complexity. Therefore, the usual assumptions about the singularity of the decision-maker, the well-defined nature of the product and the exclusively market-mediated character of the firm's transactions are avoided. The strategy here is to consider

how the hospital deals with conflicting internal objectives; how it defines its output; and how it behaves in complex non-market relations with regulatory agencies. This approach is especially necessary because most public policy alternatives in the hospital sector are embodied in quantum changes in institutional relations and regulations rather than in the usual continuous parameters of comparative statics. A theory of the hospital which failed to recognize "organizational" variables as endogenous would be powerless as a predictive or normative tool.

Hospitals are extremely heterogeneous. Some offer a basic minimum of services; others train physicians, dialyze kidneys and bypass coronary arteries. This diversity of behavior has itself contributed to the current confusion over a workable definition of the hospital's output and the nature of its motives. Considerable simplification will therefore be required. An effort will be made to focus on those characteristics which are intrinsic to an enterprise producing medical care services of some minimum degree of complexity. Uncertainty in diagnosis and treatment of illness will be seen to play a critical role in the analysis.[1] Of special importance will be the nature of the relationships between the hospital-as-firm and those economic agents (physicians)

1. Arrow [2] similarly stressed the importance of uncertainty for explaining the special features of the medical care sector.

who have a premium on medical skill and information.

The paper is divided into two parts. In the first part, the hospital will be characterized abstractly in terms of the special institutional constraints which it faces. This theoretical viewpoint will help rationalize the current organizational structure of hospitals. It will also make explicit the limitations of alternative ways of organizing such firms.

The behavior of hospitals will be shown to reflect the coexistence of two separate lines of command within the firm. Physicians, through their patient care decisions, control the internal disposition of resources. They form a group distinct from the hospital's administrators, who make the factor purchase and output pricing decisions necessary to satisfy the firm's budgetary constraints. These two sets of decision-makers will be seen to behave in conflicting ways. Given some general assumptions, this dichotomous form of organization will be shown to yield inefficiencies in internal resource allocation and distortions in external market behavior. One important source of inefficiency is the hospital's failure to conduct markets in its actual final outputs, the treatment of illnesses. Instead, it prices and sells certain intermediate production inputs (ancillary services) which it makes available to physicians in their clinical decisions.

In a separate second part, these inefficiencies are shown

to be remediable. As a matter of public policy, an organizational alternative for hospitals is proposed in which the current dichotomy of decision-making authority is eliminated. In this reorganization, the two sets of decision loci are realigned into one set of decentralized, semi-autonomous profit centers run by "physician-managers". The advantages of this proposed reorganization-- more efficient methods of internal resource allocation, of pricing hospital output, and of transacting with third-party insurers-- are considered. The implied changes in the physician's role, the difficulties involved in implementation and possible maladaptions are discussed. As with most of the literature on hospital behavior, the discussion will be somewhat speculative. However, it benefits from some intensive first-hand experience. Empirical support will be offered where available.

I. Hospitals: A Micro-analysis

The hospital is usually characterized as an enterprise offering sophisticated medical services on a large scale. A typical general hospital, for example, may serve 10,000 admissions annually, provide emergency room care, a blood bank, computerized tomography, and so forth. Although many aspects of hospital care do involve complex capital equipment or specialized labor inputs,

it would be misleading to regard the hospital's special technology as its distinctive feature. Commercial laboratories have the same automated blood analyzers; radiological outfits have similarly specialized labor assets; health screening centers may serve an equally large volume of patients. What in fact separates the hospital from these other firms is not the sophistication or scale of its production activities, but the complexity of the internal organization required to conduct these activities.

The hospital is, after all, a firm specifically designed to solve a complicated decision problem-- the diagnosis and treatment of illness. Because of the uncertainty inherent in human disease processes, this task requires an organization which can make dynamic, continuous adaptations to changing circumstances and new information. When a patient seeks the hospital's care, a contingent sequence of diagnostic and therapeutic maneuvers is usually required before a final result is achieved. Initially, diagnostic tests may be performed. Depending on the test results, particular treatments would be indicated. The outcomes of these treatments may then suggest further diagnostic and therapeutic maneuvers, and so on. Consider the following hypothetical case history.

> Mr. B presents with a fever and cough. A chest xray reveals a density. He is hospitalized. Penicillin is administered. Although the fever subsides with this treatment, a repeat xray shows that the density has not

> disappeared. A sputum cytological examination is therefore performed and lung cancer is diagnosed. Further studies suggest that the cancer can be removed surgically. An operation is performed. Unfortunately, massive post-operative bleeding occurs. Matched whole blood is administered. Despite this treatment, a cardiac arrest ensues, and emergency resuscitation (or Code Call) is announced.

When Mr. B sought the firm's services, neither his exact illness nor the inputs required for diagnosis and treatment were known in advance. In this case, the presence of cancer, the requirement for surgery and the bleeding complication were unpredictable.

Contracting: Because of uncertainty in the diagnostic and therapeutic process, "hospitalization" often becomes the most efficient means of buying certain types of medical care. Consider the specific problem of structuring a contract for Mr. B's care. To begin with, it would be near-impossible to write an exhaustive document delineating ex ante every possible step in the diagnosis and treatment. The alternative of entering into a separate market transaction for each xray and unit of blood is conceivable. It is in fact quite common in a physician's practice for a patient to engage in recurrent office visits, outpatient laboratory tests and the like. But Mr. B would have been too uninformed and at some points too ill to purchase personally each sequential component of his treatment. Even with a physician presumably acting as his agent, the task of contracting repeatedly for each drug and operation would be dangerous if not overburdening.

Hence, Mr. B's physician chose to have him hospitalized rather than be subject to the risks of repeated outpatient ivists. In effect, Mr. B purchased a rather general contract in which the firm's resources were made available as needed. His initial fever and cough were to be taken care of, whatever they turned out to represent.

Mr. B's uncertain situation is not at all far-fetched. In a great variety of situations, the patient's (or physician's) decision to hospitalize turns on the degree of unpredictability of the outcome. A woman expecting to deliver a child may (in some states) opt to purchase the separate services of a midwife at home. The alternative of hospitalization would permit her to buy not only the routine delivery, but also treatment of any potential complication, such as the need for an emergency Cesarean section. If an uncomplicated delivery were more certain, she would not have to hedge against these possibilities by electing hospitalization. In a polar case where outcomes are more certain, nonhospital services can be substituted. One example of this is the growing trend toward outpatient surgical procedures. Witness also the case of the eye surgeon who housed his operative patients in the local luxury hotel rather than in a regular hospital room.

Timing and Coordination: The hospital's ability to write

and implement an open-ended contract such as Mr. B's does not really depend on its possession of a particular production input. What matters is the firm's internal capabilities of coordinating and sequencing the use of these inputs. In many clinical situations such as Mr. B's, the appropriate diagnostic or therapeutic actions must be taken at precise times and in an exact order. Matched whole blood, for example, was indicated only in the hours after bleeding ensued. In this instance, the critical factor was the firm's ability to make blood available on a contingent basis, not its mere possession of a blood bank. In the absense of a timing problem, a specialized blood service separate from the hospital would have sufficed. Similarly, Mr. B's emergency resuscitation was appropriate only at the time of his post-operative cardiac arrest. Although one might imagine "contracting out" to a separate firm which provides such rescue procedures, there would certainly be little room for market search or haggling over terms in such circumstances. The fact is, however, that separate commercial laboratories, radiological enterprises, blood banks and even civilian rescue operations do exist. The purpose of "hospitalization", therefore, is actually the achievement of transactional economies in the coordination and timing of these production inputs.[2]

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2. This emphasis on precision timing in the internal supply of certain inputs may also explain why some hospitals invest in complex, underutilized equipment. Although an identical input may be available in another hospital, problems of imperfect access render it an imperfect substitute.

There is no easy way out of this coordination problem. For instance, the sequencing of production activities cannot always be solved by stocking physical inventories. Mr. B's emergency resuscitation involved highly specialized and adaptive human inputs, one of which was Mr. B himself. As a component of Mr. B's medical care, the Code Call had to be assembled de novo at the time it was required. Such "standby" services abound in the typical hospital. Even the task of producing a chest xray on demand requires that a technician, radiologist and certain capital services be continuously available, along with the patient, to take, develop and interpret the picture. And since the patient himself is often a special input to the performance of these services, they are not always substitutable from one patient to another.

Furthermore, it is not enough just to determine the correct diagnosis and then plug the patient into the right assembly line. Although there is a hypothetical set of reproducible treatments for each illness, each patient's case is potentially an idiosyncratic variant or a combination of several interdependent illnesses. Mr. B's primary illness was lung cancer, but there were secondary diagnoses of infection and bleeding. Not every case of lung cancer entails these additional problems. The administration of penicillin in Mr. B's case further illustrates that some treatment is often performed before the correct diagnosis is made. In addition, as in the case of Mr. B's post-operative bleeding, some illnesses

are the direct result of current treatment. And if Mr. B also happened to break his leg, this would not necessarily be an independent problem treated by a separate technology. It might be a pathological fracture (i.e., a manifestation of spread of the underlying caneer) and would therefore require a different treatment than the usual broken bone regimen. In effect, the end-product pruchased by any one consumer of hospital care may require a combination or sequence of inputs different from that of any other. The diagnosis and treatment of illness is custom made for the buyer.

Medical Care: The above properties of hospital production are not unique. The provision of most personal services requires some degree of adaptation to uncertainty and a custom made approach. But hospital care represents an unusual extreme. This presumably has something to do with the vagaries of human biology and the "life and death" nature of the product. It would be too digressive here to discuss extensively the problem of the "value of life". However, a few comments will be helpful in preparing the argument below. First, the benefit or utility function of the consumer of hospital services possesses extreme discontinuities with respect to the range of possible outcomes. Marginal benefits may be infinite (or negatively infinite) for small variations in production inputs. The wrong dosage or timing of a drug can have disastrous consequences. As a result, the production process requires the kind of precision which can often

be achieved only by recurrent, well-practiced interactions within a firm. Second, as a corollary to the above, medical care decisions cannot always conform to the usual assumptions of the expected utility theory. In many situations, the preferred action is a sort of regret-minimizing strategy in which "everything possible" is done to hedge against the possibility of a death outcome. As will be seen, this makes it difficult to rely on price signals based on expected marginal values. Third, despite the existence of methods for allocating the risks of adverse health, the problem of compensation for a "life" renders them imperfect. From the patient's viewpoint, there is only incomplete elimination of risk from the consolidation of independent illnesses. The potential disutility resulting from any combination of outcomes in which one dies is seen to be as large as that for one's own death independently. What this means is that some non-market, institutional means of spreading risks is necessary.[3] As will be seen below, all of these conditions have significant influence on the internal organization of the hospital.

Physicians as Decision-makers: The hospital's essential feature as a medical care enterprise, therefore, is its ability to coordinate production inputs internally with a high degree

3. See Arrow's [2] original discussion of the non-marketability of bearing certain risks related to illness.

of precision. In the face of this conclusion, one may ask how the firm actually accomplishes this feat. To begin with, there is a specialization of "local" and "global" functions within the organization. Despite a limited number of possible diagnostic and therapeutic inputs, there is in each patient's case a potentially infinite variety of combinations of these inputs. With each patient requiring a different sequence, it would be impossible for a central command to keep track of and supervise every case. Some degree of decentralization of decision-making is therefore necessary in order to allocate resources among patients. To this end, it would be useful to differentiate the "local" task of choosing the appropriate sequence of inputs for a given patient from the "global" task of insuring the availability of these inputs for all patients. In that case, local decision-makers can specialize in the diagnosis and treatment of their assigned patients' cases. These decisions will create internal demands for various resources, and the global task of making these resources available within total supply constraints is then the function of global managers.

The local decision-maker corresponds to the physician, who has acquired the special skills and information necessary to supervise patient care. Mr. B's physician, for example, initiated his hospitalization, ordered his xrays, directed his

surgery, and requested his transfusions. These local decisions are distinct from such global considerations as what the total number of operating rooms or units of blood should be. Thus, when a physician requests an xray, he does not directly purchase and stock the film; nor does he directly hire and remunerate the radiological technician, procure the xray equipment or ensure the availability of the xray service on demand. The physician's local decision to utilize a particular input creates an internal demand for certain primary factors and the requisite labor and capital services are then supplied by other agents concerned with the global allocation of resources.

This local-global specialization distinguishes the hospital from the solo or group physician practice. In these simpler enterprises, the physician serves to some extent as both a (local) medical professional and as a (global) manager. But in the hospital, the burden of employing, monitoring and coordinating the factors of production has precluded joint managerial and professional roles. A distinct class of hospital managers has therefore arisen to perform the global functions.

Professionalism: This separation of duties in the firm is not merely a case of comparative advantage. Of equal significance is the insulation from global considerations of resource availability which is obtained by the physician. From the "global" standpoint, it is worth asking whether the expected

marginal benefit of Mr. B's emergency transfusions and Code Call matched the marginal costs of the resources involved. After all, Mr. B had an underlying malignancy whose 5-year cure rate is generally about 9 per cent and only about 50 per cent in the most favorable cases.[4] From the "local" standpoint, however, application of this conventional cost-benefit calculus to Mr. B's case would run into some difficult problems. In the absence of any established valuation of a cured case of lung cancer, Mr. B's physician can at best make subjective assessments of the expected gains of the resources he requests. These assessments will invariably involve interpersonal comparisons between Mr. B and others. Furthermore, the accepted institutional solution to the absence of a market mechanism for bearing the risks of serious illness has been to assign to the physician a sense of "ultimate responsibility" for the outcome of his patient's care. The imposition of this ethical burden motivates the physician to take a narrowly oriented view of his actions as affecting only Mr. B. As Mr. B's agent, his physician would be under a professional obligation to "do everything possible" to hedge against a death outcome. Under these conditions, it is frequently argued that the physician need not and ought not know the social opportunity

4. See [9] for a general discussion of the current status of diagnosis and treatment of lung cancer.

costs of the resources he deploys.[5] The practice of functionally differentiating local clinical decision-making from the global task of ensuring resource availability appears to contribute to this end.

The Physician-Hospital Relation: The physician's insulation from global considerations of resource allocation may help him to maintain his professional stance, but it renders the economic relation between the physician and the hospital ambiguous. For purely functional purposes, the physician is an employee of the firm who, as a result of his sepcialized decision-making capacity, makes internal demands for certain diagnostic and therapeutic inputs. But from the standpoint of a "professional" with a special ethical burden to protect his patient, the physician has become an autonomous agent separate from the hospital, externally demanding the firm's product on the patient's behalf.

The situation is analogous to that encountered in discussions of vertical integration.[6] In a sense, the physician is in the position of a downstream firm which fabricates an end-product (medical care) from certain inputs (xrays, operations, etc.). These inputs are in turn supplied by an upstream firm, which in this case is the hospital. Because of special characteristics of

5. For a more extensive discussion, see [19] , especially the contributions of Arrow and Halberstam.
6. See for example Williamson [21].

the downstream technology discussed above (uncertainty, lack of standardization, problems of timing and coordination, etc.), it becomes impractical for the downstream firm to procure the necessary inputs from the upstream firm by means of recurrent market purchases. Some form of continuous, non-market supply relation would be preferable. In the same manner, the physician as the patient's agent must maintain a continuous supply relation with the hospital. In order to deliver on Mr. B's open-contract to be treated for whatever illness arises, his physician as his agent must be in a position to procure the necessary inputs. As discussed above, it would be impractical for Mr. B or his physician to haggle over market sales terms during Mr. B's Code Call.

In the analogous vertical integration case, there is typically a tradeoff between the autonomy permitted by a market sales arrangement and the transactions costs savings achieved by merger. If it merges, the downstream firm loses both its independence and its exclusive right to the profits from its sales of the end-product. Similarly, the formation of a continuous non-market supply relation with the hospital would seem to be at the expense of a loss of the physician's separate identity as an entrepreneur and his exclusive rights to the income from his practice. Such a "merger" would render the physician an

employee of the hospital.[7]

It is an essential feature of the physician-hospital relation that this potential tradeoff is eliminated. The physician, somehow, seems to get both: he is privileged to make recurrent demands on the hospital's resources without becoming a formal employee. Quite contrary to the conventional view of employment as an arrangement in which the firm has some command over the employee's performance, the physician enjoys an almost unbounded range of discretion in his decision-making. Rather than receiving a wage, he retains full claim to the income derived from his activities. To be sure, even the conventional employment relation involves some degree of discretion on the employee's part. But incentives are usually structured so that the employee's autonomy is well-circumscribed and his performance can be easily monitored. By contrast, the physician is given full entitlement to deploy any combination of resources he chooses for his patient within the constraints of short-run factor supplies.

To a great extent, the physician's wide-ranging autonomy within the firm is the result of the ethical protections he enjoys. "Do everything possible" strategies may be invoked (strategically or not) whenever an attempt is made to impose

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7. For a general discussion of the concept of "employment relation", see Williamson, Wachter and Harris [22].

operating rules designed to restrict the physician's decision-making authority or promote efficiency. If Mr. B's physician were informed that his request for emergency whole blood transfusions exhausted a quota or exceeded a budget, he would respond that such action would be life-saving and could not be withheld at any cost. It is difficult to intervene in this type of situation.

In addition to the problem of enforcing imposed rules, it is not entirely clear in the first place how to design such a set of operating rules. The problem is that the unstandardized character of the firm's product makes it difficult to measure directly the physician's performance. The hospital may attempt to compare a particular physician's patient care decisions with known standards. But since idiosyncratic outcomes are so prevalent, it is usually very costly to investigate deviations in any systematic way. Measurement of the number of xrays or transfusions ordered per case treated will not indicate whether these specific inputs were in fact necessary in a particular patient's illness. Mr. B's physician was treating him first for a respiratory infection and then for cancer and for bleeding. The necessary resuscitation and transfusions were not "standard practice" for lung cancer. Yet an attempt to cite Mr. B's physician for violation of an internal standard would meet with the objection that Mr. B's case was a special exception. Since

the ultimate responsibility for the outcome is assigned to the physician, he should be entitled at least to due process in justifying actions which appear deviant. Given the prevalence of such special cases, extensive use of review procedures would be impractical. In the end, there is no substitute for relying on the physician's self-imposed norms of conduct. It is therefore not clear how to construct a set of operating rules based on performance or, even if they could be designed, how to enforce these rules.[8]

All of the conditions thus far discussed place the physician in a strategic position within the firm. Because the physician's specialized role as a local decision-maker is essential to the firm's production technology, and because recurrent market contracting for each phase of diagnosis and treatment is infeasible, the physician engages in a continuous supply relation with the hospital. But because of the complexity of any potential rule enforcement system and the ethical burden placed on the physician, this supply relation cannot be easily subject to the usual constraints implied by "employment". The physician cannot be ordered to do this or do that in return for a wage. If income preferences and a desire for professional autonomy are assumed operative, then the physician would naturally take advantage of these special conditions. He retains his identity as a distinct entrepreneur, and with it the claim to the residual yielded by

8. For a more sanguine view of "peer review", see [9]. One might also ask why an internal price system wouldn't work in this case. Discussion of this possibility is deferred to below.

his activities.

Formal Organization: In order to preserve the physician's autonomy in the face of the strong interdependence between physician and hospital, a complex institutional arrangement has been devised. In addition to the specialization of physicians' and managers' functions, there is an organizational separation of these two types of agents. Although the technology of patient care requires that physicians and managers make continuous supply-demand interactions, they are intentionally segregated in the firm into two distinct subdivisions.

Consider the typical formal "organization chart" of a hospital. The conventional "voluntary" hospital-- which is by far the most prevalent form in the United States-- is a corporation with a Governing Board as its ultimate authority.[9] Although this Governing Board generally delegates operating responsibility to the hospital's "Administration", there is actually a second separate line of authority emanating from the "Medical Staff", which constitutes the firm's affiliated physicians (see Figure 1).

The Administration functions as the firm's managers. It

9. Strictly speaking, governmental and so-called "for-profit" hospitals are not organized exactly as described here. However, since the basic organizational separation of physicians and hospital also prevails in these cases, a similar argument can be applied. Because the voluntary hospital is the major brunt of current public policy discussions, it will be analyzed here.

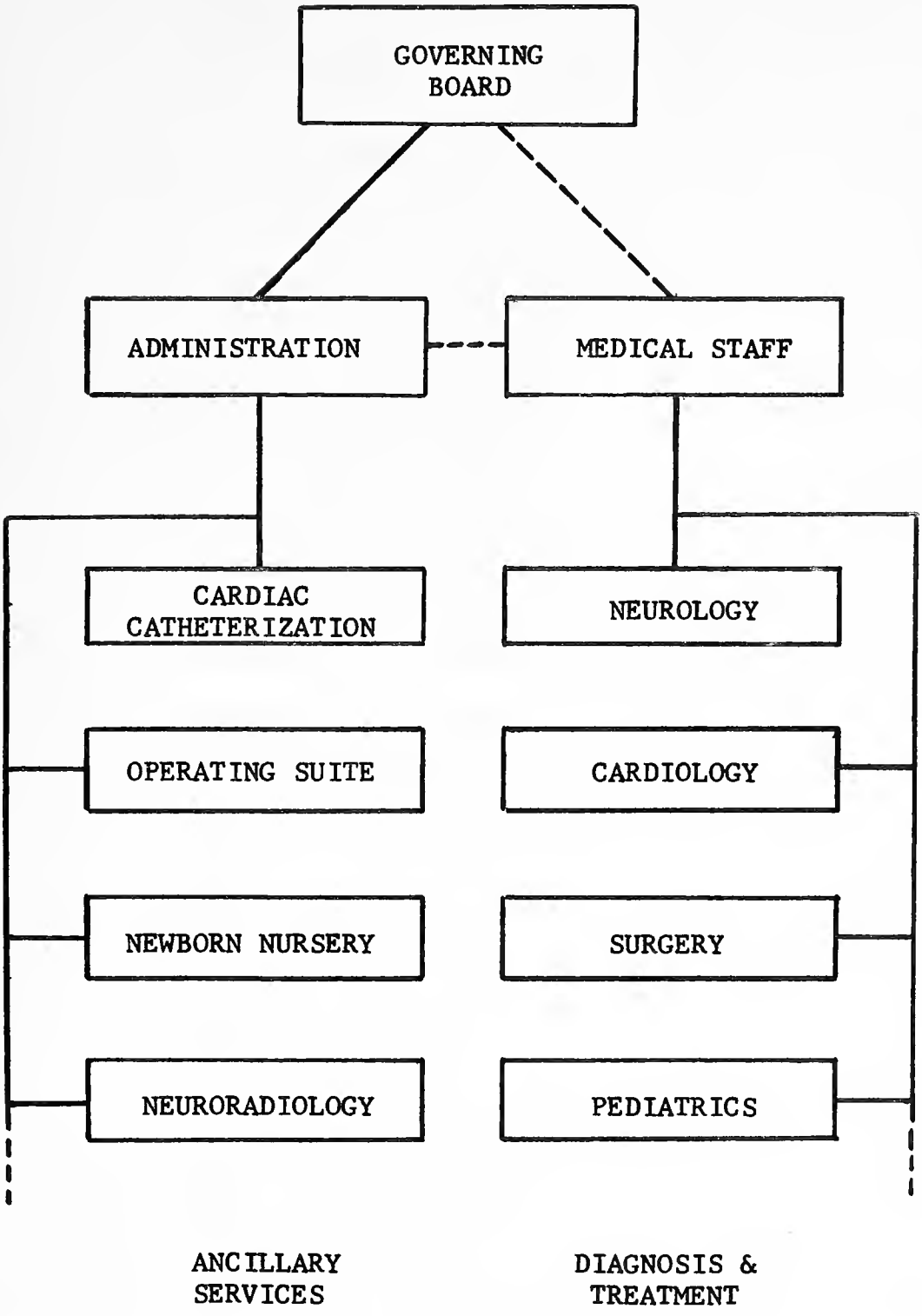
GOVERNING BOARD
ADMINISTRATION
MEDICAL STAFF
CARDIAC CATHETERIZATION
NEUROLOGY
OPERATING SUITE
CARDIOLOGY
NEWBORN NURSERY
SURGERY
NEURORADIOLOGY
PEDIATRICS
ANCILLARY SERVICES
DIAGNOSIS & TREATMENT

Figure 1

has general responsibility for purchasing the factors of production, operating and pricing the various services offered by the firm (termed "ancillary services"), interacting with third party insurers, etc. That part of the organization chart under the Administration is structured functionally according to the various types of ancillary services offered (see Figure 1). Electrocardiograms are offered by Electrocardiology Department; blood products by the Blood Bank; nursing care by the Department of Nursing; drugs by the Pharmacy.[10] In order to ensure the availability of an xray, for example, the Radiology Department (under the Administration) procures technicians, film, xray materials, dispatchers and other inputs. These primary factors of production are then combined to produce an xray service when it is required locally for a particular patient.

The Medical Staff performs the local decision-making functions The member physicians are solely responsible for the care of individual patients. That line of command under the Medical Staff is also organized functionally, according to the various

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10. Strictly speaking, hospitals' accounts do not regard nursing services as an ancillary service. Hotel-type amenities (e.g., dietary service, laundary) and support departments (e.g., payroll, accounting) are also under the Aministration but similarly not considered ancillary services. The simplification employed above stresses the internal supply function of the Administration.

specialty branches of the member physicians. This functional departmentalization corresponds to a categorization of the various types of patient's illnesses treated in the institution (e.g., Surgery, Neurology, Pediatrics; see Figure 1). Thus, the firm is organized into two separate types of departments: local demand departments of the Medical Staff and global supply departments of the Administration.

In the face of this formal dichotomous organization, performance of the hospital's complex internal coordination task requires some special adaptations. For every patient treated, a contingent sequence of interdepartmental transactions is necessitated. The patient's admitting physician, who is in a particular Medical Staff department, will make numerous adaptive decisions in the course of diagnosis and treatment. Each decision will create an internal demand for some ancillary service. In response to each spot demand, a separate Administration department will supply the appropriate input. For example, because of Mr. B's fever and cough, his physician (a member of, day, the Department of Internal Medicine) ordered an xray and subsequently penicillin injections and a sputum cytology, among other ancillary services. In response to these orders, the Department of Diagnostic Radiology fabricated an xray service; Pharmacy supplied the necessary drug; and the Cytology Department processed the appropriate sputum samples. When an operation was indicated, a Medical Staff

member of, say, the Department of Thoracic Surgery was consulted. The ancillary services of the Operating Suite were then requested.

In effect, production is accomplished by a sequence of spot transactions under uncertainty. Since the Medical Staff and Administration departments are formally separate, all of these internal transfers of ancillary services must go from one supplying department to a separate demanding department. As a result of this organizational separation, no single department is responsible for both the provision of ancillary services and the diagnosis and treatment of illness.[11] As a result of this strong interdependence, no patient can be cared for completely without at least one demand-supply transaction between a Medical Staff and Administration department.

Again, the situation closely resembles that of a two-stage vertically integrated firm. Upstream, departments under the command of the Administration produce ancillary services from primary factors of production. These ancillary services cannot usually be stocked as physical inventories; they cannot be arranged in fixed assembly lines; and they must be made available on demand with precise timing. Downstream, physicians in

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11. Physicians performing deliveries, for example, are typically members of a Department of Obstetrics and Gynecology. But the delivery suite itself, along with the relevant equipment and support personnel, is managed by an Obstetric Unit under the Administration.

Medical Staff departments combine these services to produce an end-product-- the diagnosis and treatment of their patients' illnesses. The ancillary services thus become a type of intermediate production good supplied upstream and demanded downstream. Although production requires continuous transactions between these upstream and downstream departments, the two stages of production are organized separately into distinct vertically integrated divisions of the firm.

The organizational separation of these two stages of production, it is emphasized, is no historical accident. It represents a compromise between the special autonomy achieved by the physician and the transactional interdependence of physician and hospital. In order to maintain a continuous supply relation with the hospital, the Medical Staff has "merged" with the Administration. But this vertical merger is carefully circumscribed by a complex set of property rights and operating rules intended to preserve the physician's decision-making autonomy and his right to a direct claim of the residual from his activities. The firm is made to look more like a loosely integrated vertical merger than a single enterprise.

The institutional evidence for this interpretation is plentiful. Neither the Administration nor the Governing Board has direct control over the Medical Staff members (hence the

hatched lines in Figure 1). Only the physician may decide what patients shall be admitted, how long they will be hospitalized and what resources they shall receive. This control loss extends beyond the physician's patient care decisions. The Medical Staff alone dictates the contractual relations and policing of its physician members (see [10]). It independently grants "staff privileges"to admit patients and command the firm's resources for their treatment. It alone can fire or discipline one of its members. To be sure, many Medical Staffs do have rules concerning professional ethics, types of patients admitted, extra-hospital activities, methods of remuneration, etc. (see [17] , chapter 8). And more sophisticated staffs have made attempts at reviewing the use of various hospital resources by members. But these contrc at best represent a form of indirect self-policing.

Moreover, contrary to the conventional view of the employment relation, physician members of the Medical Staff are generally not salaried by the firm. Although certain training institutions hire resident staff and teaching faculty, the typical practicing clinician receives no remuneration from the hospital for his activities. Instead, physicians' income from hospital practice is derived from a system of charges separate from that of the hospital's services. This applies even to those physicians (such

as anesthesiologists and radiologists) whose clinical activities are confined to the hospital setting.[12] The hospital itself, under the management of the Administration, is entitled only to the residual derived from the provision of its ancillary services; that residual derived from the physician's activities is claimed directly by the physician. The physician pays no fee for the right to use the firm's resources; the costs of ancillary services are solely the responsibility of the patient or third-party insurer. This means that for every hospital admission, the patient receives two bills-- one from the hospital and one from the admitting physician.[13]

Internal Resource Allocation: Because of the organizational separation of two stages of production, a complex set of operating rules is required to accomplish that sequence of spot transfers of ancillary services which constitutes hospital care. These allocational rules are carefully fashioned so as to respect the Medical Staff's institutional autonomy. When a patient is admitted to the hospital, all of the local allocational decisions relevant to that patient's care are made in the form of "physician's orders".

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12. Physicians of this type usually do not practice independent clinical medicine. Instead, they are under contract with the hospital to assist in the production of ancillary services (e.g., read xrays and electrocardiograms). Nevertheless, their remuneration for these services is governed by Part B of Medicare and Blue Shield.

13. This provides another important distinction between the hospital and other forms of physician practice.

In response to these downstream orders, the Administration departments upstream make the indicated ancillary services available to that patient. Since services must be available globally for all patients, it is the responsibility of the Administration to ensure an adequate short-run supply of those primary factors necessary to produce these intermediate production goods. Because the Administration has no means of dictating the physician's internal demand for ancillary services, it must somehow anticipate ancillary service requirements and, subject to short-run budget constraints, procure the necessary primary inputs. This is no easy task: textbooks on "hospital administratic are ostensibly written to solve this problem, or at least to explain it.

The resulting allocational system is a sort of quantity-based nontatonnement scheme. The physician makes an internal quantity order for an xray, blood, a Code Call, and internal suppliers either deliver or announce that internal supplies are exhausted. Anyone who has had an anticipated operation cancelled because no operating rooms were available or who has had to wait in a long cue for an xray would be familiar with this phenomenon.

Why Not Prices? One might wonder in that case why the Administration does not use the price mechanism to solve its allocational problems. If operating rooms or xrays are in

excess demand, why shouldn't an internal price for these ancillary services rise to clear the market? Or if an operation or transfusion is deemed to be an emergency by the demanding physician, why shouldn't the Administration quote a higher price for this higher priority item? Wouldn't an internal price system for ancillary services provide a means of influencing physicians' decisions without directly intervening in clinical practice?

In response, it must be acknowledged that the hospital does quote "prices" for its ancillary services. The typical hospital bill, in fact, is a detailed enumeration of standard charges for each ancillary service consumed by the patient. Mr. B, for instance, would be billed for a certain number of days in the hospital, hours of operating room time, types of drugs, units of blood, and so forth. In practice, this system of charges is extremely complicated, since the hospital must make the "price list" conform to the particular terms of the third-party payer.[14] But the fact is that these are purely revenue-collecting devices and have no real significance in the allocation of resources. That is, they have no demonstrable effect on the physicians' demands for ancillary services. Furthermore, these prices are often based on historical consensus and have little

14. The hospital quotes a standard set of "charges" to uninsured consumers and private insurers. For Blue Cross, Medicare and Medicaid, a "reimbursable cost" is calculated which is used in settlements at the end of a financial period.

relation to actual costs.

The absence of meaningful internal prices depends to some extent on the physician's professional resistence against economic considerations in clinical decision-making. But even if cost calculations were removed of their unprofessional taint, the physician has no economic motivation to use them in his decisions or even to know their magnitudes. After all, the physician bills the patient only for his services rendered and the hospital collects the remainder. Since the patient is accountable for these costs, the physician might be expected to be sensitive to the patient's demand curve. Indeed, decisions which appear to be price-motivated are sometimes made. But these occur unsystematicall and are based upon limited information about ancillary service prices. The fact is that most physicians are ignorant of the charges made for the ancillary services they order,[15] and this is because they don't have to collect the bill themselves.

The physician's inability or refusal to respond to meaningful internal prices is admittedly relative. If professional attitudes toward cost considerations could be influenced, then internal prices could be tried. But there is still a more fundamental problem. Ancillary services are intermediate production goods which must

15. Empirical data on this point are scant, but it is generally acknowledged to be valid. See, for instance, the study in [13], which showed that physicians are generally poorly informed of drug costs.

be allocated under uncertainty. These intermediate goods have only short-run, limited substitutability and frequently cannot be stockpiled in physical inventories. Marginal benefits vary to extremes for small errors in the combination and sequence of these inputs. Under these combined conditions, it may be disastrous to announce a price for a particular ancillary service (presumably based on its expected marginal value) in the hope that the optimal quantity is supplied. There are bound to be situations such as Mr. B's Code Call where excess demand could not be tolerated. Because of limited substitutability, the absence of inventories and problems of timing, there is just no margin for error. The costs of disequilibrium are so high that it would be better to declare by fiat the appropriate market-clearing quantities than "fool around with prices".[16] Unless there were perfect information and anticipation of every occurrence, there will have to be cases where quantity-based rationing prevails. At the least, a mixed price and quantity system is necessary.

If the hospital cannot use ancillary service prices as internal signals, then why does it bother to calculate them at all? The answer is that the hospital has no other practical means of collecting its revenues. Although the actual end-products

16. Problems of this kind with the use of prices are more fully discussed in Weitzman [20], from which this phrase was borrowed.

of hospital production are the diagnoses and treatments of various illnesses, the current system of hospital-physician property rights prevents the firm from marketing them as well-defined priceable commodities. Because the physician bills the patient separately, the hospital can do no better than to sell its output as if it were a bundle of ancillary services. This may appear paradoxical, since the price of treating the entire illness episode should be the economic magnitude to which the demander of hospital care responds. Every patient's admission does in fact have an implied total price, namely, the sum of the hospital's ancillary service charges and the physician's separate billing. But in the hospital's financial accounts and in its interactions with third-party insurers and regulators, these illness-based prices play no explicit role.[17]

The use of these ancillary service prices rather than final product prices prevails for all of the firm's external transactions. Most private insurance companies reimburse the hospital according to the total price of ancillary services consumed by the insured patient on a particular admission. The major third-party schemes (Blue Cross, Medicare and Medicaid) involve complicated financial settlements, but reimbursements are

17. Until recently, most hospitals could not even provide data on the mix of illnesses treated. Administrators devoted their energies to the "global" task of accounting for ancillary services consumed. Those"local" medical reasons why the patient required a particular service were separately detailed in the patient's medical record. Each division of the firm had its own separate information system.

also based on enumerated costs of ancillary services. Some governmental reimbursement contracts essentially attempt a form of "rate regulation". For example, if the firm announced total charges of x for a particular ancillary service, the "regulator" might declare a "reasonable reimbursement" to be $0.9x$, on the presumption that a certain fraction of declared charges is excess profit or the result of remediable inefficiency. These systems of reimbursement consider only the appropriate rate of return on the cost of ancillary services used. There is no explicit consideration of the appropriate return on the treatment of a particular illness.[18]

Under the current system of organization, the hospital has little motivation to alter its pricing practices. Reimbursement on the basis of ancillary services permits the hospital to shift to the consumer the risks arising from uncertainty in the costs of treatment. If the firm quoted a fixed price for a case of "lung cancer", it would have to contend with the possibility of revenue losses from catastrophic illnesses such as Mr. B's. If a separate price for a "complicated case of lung cancer" could be devised, and if the firm were permitted to label the particular case treated ex post, then some of this adverse selection would

18. Although numerous case-mix based reimbursement schemes have been proposed (see for example [6]), to the author's knowledge there are none functioning on more than an experimental basis.

be eliminated. But such an arrangement would invite cheating (i.e., announcing the most expensive diagnosis) unless each case could be carefully monitored. Reimbursement agencies have therefore avoided these potential transgressions by relying on the current system of cost accounting according to ancillary services.

Efficiency Considerations: Although the hospital's actual end-products are the diagnoses and treatments of illnesses, there is thus no real market in these economic goods. Instead, the firm deals in open-ended contracts for the spot delivery of an uncertain bundle of intermediate production goods-- namely, ancillary services. The exact combination of these ancillary services delivered is determined by the physician's decisions. Since these decisions are professionally inviolable, the firm must regard them as constituting an external demand for its ancillary service products. The firm therefore behaves as if it sells xrays and operations to physicians, who buy them on their patients' behalf. Although the consumer buys "treatment for what ails him",[19] the hospital does not abide by this description of the product in its transactions.

This interpretation provides some insights into the sources of inefficiency in the hospital's internal resource allocation

19. This phrase is borrowed from Anne Scitovsky [18], who originally proposed an indicator of the consumer cost of medical care based on the prices of selected illnesses rather than hospital production costs.

and external market behavior. Rather than regard itself as an integrated firm, the hospital in effect views itself solely as an upstream supplier of services. As a result, "efficiency" is regarded in an illusory fashion as the least-cost production of ancillary services, not as the least-cost treatment of illness. Net revenues are also calculated on the basis of ancillary services and not case mix. For example, hospitals are regarded as making profits on lab tests and losing money on emergency ward services. But one rarely hears the assertion that a particular institution "breaks even on its lung cancers".

If the efficiency calculus if based upon the firm's actual outputs, the consequences of the lack of physician accountability in this vertically integrated firm become manifest. Let the hospital's technology be described in activity analysis terms as follows.[20]

(i) Technology- Production is carried out in two stages, upstream and downstream. Corresponding to each stage is a (row) vector of basic activities, x_U and x_D respectively, which represents the non-negative activity levels for the upstream and downstream basic activities. Assume three types of commodities: primary, intermediate and final,

20. The intention here is not to fabricate a complete formal model, but rather to make the necessary points in an analytical, and hopefully more lucid fashion. The definitions developed here will be used more extensively in part II of this paper.

the net outputs of which are defined by the (row) vectors y_P, y_I, and y_F respectively, with the entire commodity vector represented as $y = (y_P, y_I, y_F)$.[21] Assume a production technology described by the dontinuous function $y = G(x_U, x_D)$ with the following properties:

a. G is separable for x_U and x_D, that is, it can be written in the form $G(x_U, x_D) = g(x_U) + h(x_D)$, where g and h are continuous functions;

b. $y_F > 0$ if and only if $x_D > 0$; if $x_D = 0$, then $y_F = 0$;

c. If $y_I < 0$ then $x_D > 0$; if $y_I > 0$ then $x_U > 0$;

d. If $x_U = 0$ and $x_D = 0$, then $y = 0$; if $x_U > 0$ then $y_P < 0$; if $x_D > 0$, then $y_P \leq 0$;

e. G has the usual convexity (non-increasing returns) property that for $t \geq 0$ any scalar, $ty \leq G(tx_U, tx_D)$.

Under the activity model, each downstream activity transforms intermediate and primary commodities into final commodities. Each upstream activity transforms primary commodities into intermediate commodities. The obvious interpretation is that ancillary services are intermediate commodities, primary factors of production are primary commodities, and treated illnesses

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21. Follow the sign convention that net outputs are positive and net inputs are negative. In the text below, let the relation ">" for vectors mean that at least one coordinate in the left-hand side is strictly greater than the corresponding coordinate in the right, and conversely for "<". The relation "$\geq$" means "not<" and conversely for "$\leq$".

are final commodities. Convexity permits efficiency to be achieved by profit maximization (or cost minimization).[22]

Consider the following scenario. Suppose that the firm must treat a minimum number of patients $\bar{y}_F > 0$ in a single time period. Let w_P be the (column) vector of fixed prices for primary factors and consider the problem of minimizing total costs $-y_P w_P$ such that $y_F \geq \bar{y}_F$ and $y_I \geq 0$. To conform with existing institutional constraints, let physicians get to choose x_D first. Administrators will then choose x_U. Since final products can only be produced by downstream activities, physicians will choose some x_D^* so that for $y^* = h(x_D^*)$, $y_F^* \geq \bar{y}_F$. This choice, however it is motivated, will create internal excess demands for ancillary services $y_I^* < 0$. The Administration must now choose some $\tilde{x}_U$ such that for $\tilde{y} = g(\tilde{x}_U)$, $\tilde{y}_I + y_I^* \geq 0$. But unless <u>both</u> $\tilde{x}_U$ and x_D^* were chosen efficiently, there is no reason why the combination $(\tilde{x}_U, x_D^*)$ should be the least-cost mode of producing $\bar{y}_F$. Of course, if the appropriate efficiency prices w_I were calculated for the intermediate goods, this problem

22. The informal model presented abstracts from considerations of uncertainty or many time periods in order to make the point that the Administration's inability to control the choice of x_D is sufficient to generate inefficiency.

could be solved by requiring that physicians choose x_D to minimize costs $-y_I w_I$. But current institutional conditions constrain the Administration from imposing transfer prices or cost-minimizing rules upon physicians' choice of x_D.

This is not a profound result, but it does make the important point that inefficiency depends only on the Aministration's inability to send the right signals to physicians. It does not formally depend on physicians' motives in choosing x_D or the details of the technology or the unanimity of physician's motives. Even in a fixed-coefficient, linear world in which one physician decided all of the x_D, he could still make the wrong choice of techniques.[23] It also does not imply that managers are cost efficient or even want to minimize cost. The firm will still be inefficient if they do.

The comparative statics of the model yield some perverse conclusions. Suppose, for example, there there were a change in "climical practice" (that is, in the function $h(x_D)$) so that the input requirements of a particular ancillary service requirement for a particular illness was increased. Physicians might, for example, order more electrocardiograms during heart attacks.

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23. Models by Manning [14] and Pauly and Redisch [16] do recognize the significance of the physician's decision-making authority. The conclusions of these models, however, are based upon specific assumptions concerning the multiplicity of decision-makers, physicians' income motivations and a variable coefficient technology They do not consider the more fundamental problem of how the firm works at all.

Whether this is interpreted as increased "thoroughness" on the part of physicians (i.e., higher quality of medical care) or merely technical inefficiency, the fact is that the Administration would view it solely as an increase in the "demand" for electrocardiograms. In a world where Administrations were motivated to maximize revenues, quantity of ancillary service output, or sophistication of capital stock, one could see how this "demand increase" would be viewed favorably. Even if managers are viewed as passive instruments with pure efficiency objectives, there is still no check on this type of behavior.[24]

It is similarly irrelevant what appropriate rate of return is allowed on the upstream stage of production if the choice of x_D is not affected. Unless the target of regulation is the cost of diagnosis and treatment, these sources of inefficiency will prevail. Medicare might attempt to induce cost-cuts in the production of ancillary services by decreasing the allowed reimbursement for electrocardiograms or days in the hospital, but as long as the decision as to the input requirement for electrocardiograms or length of stay is uncontrolled, there is no reason for the total cost of care to decrease.

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24. The "non-profit" or "for-profit" status of the firm would therefore not be the major factor in determining efficiency as long as the fundamental separation of physician and hospital were maintained. Arguments to the effect that "for profit" status would curb the discretionary behavior of hospital managers do not address the major potential sources of inefficiency. See [4].

Direct evidence that the hospital's inefficiencies lie in the physician's choice of techniques rather than in the production of services is difficult to assemble. There is, however, some indirect evidence from a number of sources. There is evidence that in other health delivery settings (such as prepaid group practices) where incentives to minimize costs can be imposed on physicians, the utilization of hospital bed-days and both inpatient and outpatient services drops considerably without demonstrable change in health indices. Despite the popular notion that there is a standard set of fixed treatments for each illness, the available data suggest that there is actually considerable substitutability. Studies of the clinical technology for treating breast cancer [8], heart attacks [12], and hernias [7] all suggest that physicians could reduce length of stay and the intensity of other service inputs without jeopardizing their patients. Empirical studies of hospital costs generally confirm the importance of case-mix as well as intensity of services as explanatory variables (see for example Feldstein [5]). There is also the important finding that type of reimbursement rule or the extent of direct control by third parties appears to have little effect on cost or other efficiency measures in the hospital (see for example Pauly and Drake [15]).

II. An Organizational Alternative

Despite the institutional constraints discussed in part I, the inefficiencies of the current system of hospital organization are remediable. The required changes cannot be achieved, however, by manipulation of market instruments external to the hospital. As a matter of public policy, revisions in the internal organization of the enterprise are necessary. An alternative organization for hospitals will therefore be suggested which eliminates the dichotomous organization elaborated above. Such a reorganization will in turn require changes in the relation between physicians and hospitals and in the method of internal resource allocation in the firm.

A critical element in the analysis has been the emphasis on the organizational separation of physicians and managers. This organizational separation was explained as a devised solution to the problem of insulating the physician from his potential status as an employee. In the face of this organizational separation, the hospital had to make special adaptations in order to achieve the precision coordination under uncertainty required for hospital care. This was accomplished by a system of contingent spot transfers of intermediate goods between Medical Staff and Administration departments. This arrangement was unfortunately not compatible with an efficient and enforceable set of operating rules. In particular, special conditions related to the benefit

function of the consumer, the nature of medical decision-making and the ethical insularity of the physician precluded the use of a system of internal prices. As an adaptation to this failure of organization, the hospital participated in markets in ancillary services rather than in its actual end-products, treated episodes of illness. When the efficiency calculus was performed in terms of these final goods, numerous distortions became apparent.

In the informal activity analysis model presented above, the fact of organizational separation was embodied in the rule that "physicians choose x_D and management chooses x_U". Consider instead the following more general definitions.

(ii) Definition: A "department" of the firm is a single decision-making unit which is responsible for choosing the levels of specific basic activities. A "departmentalization" of the firm is a partitioning of the vector $x = (x_U, x_D)$ of basic activities so that each subvector of the partitioning is decided upon by one and only one department.

A departmentalization is therefore a complete set of assignments as to who controls what basic activity. As a definition of organization, it is sufficiently general to include the current dichotomous organization as a special case.[25] In particular,

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25. Since the definition requires that only one department control any particular activity, no "duplication of responsibilities" is permitted. However, if one wanted to assign a particular basic activity x_i to a second department, one could define an additional basic activity $x_{N+1}=x_i$ and partition the augmented activity vector (x, x_{N+1}).

the institutional separation of physicians and management dictates that no single department can be responsible for both the production of ancillary services and for the diagnosis and treatment of illness. Therefore,

(iii) Constraint: The current system of hospital organization imposes a constraint on the possible departmentalizations of the firm. That is, no subvector of the partitioning of $x = (x_U, x_D)$ can contain coordinates from both x_U and x_D. The vectors x_U and x_D must be partitioned separately.

The assumption in (ii) that each department behaves as a decision unit emphasizes the potential incompatibility of physicians' and managers' choices. As long as the firm's departmentalization adheres to the constraint (iii), there is no difficulty in assuming unanimity within a single department. Each department under the Administration is presumably commanded by a manager. Although physicians make their own clinical decisions individually, members of the same Medical Staff department are usually aware of each other's priorities and concepts of standard medical practice. Without restriction (iii)-- so that physicians and managers would be permitted in the same decision unit-- changes in the relationship between physicians and the hospital would be necessary.

Before proceeding further, consider the following

definitions.

(iv) Feasibility and Efficiency: Suppose that $\bar{y}_P$ is a vector of non-positive constraints on primary commodities. Let $y = G(x_U, x_D)$. The vector x of basic activities is said to be feasible if and only if $y_P \geq \bar{y}_P$ and $y_I = 0$. A feasible x is said to be efficient if and only if there is no feasible $x^* \neq x$, with $y^* = G(x^*_U, x^*_D)$, such that $y^*_F > y_F$.

The question now arises, given the institutional constraints imposed on the hospital, is there a "best departmentalization"? Is there any departmentalization compatible with a simple operating rule to guarantee efficiency? In response, it must first be emphasized that this is not an empty question. Organizational form considerations are relevant to the hospital's efficiency problem. This is because internal prices for intermediate commodities are not permitted.

(v) Constraint: An internal price system for intermediate commodities y_I is not possible.

If a price system for y_I were viable, then it would be irrelevant where a decision variable was assigned. Profit maximization as an operating rule would render all decision "consistent". But in the absense of such signals, there is generally no mechanism to guarantee the consistency of interdepartmental transactions in intermediate goods. As a result, it matters who makes what intermediate goods available to whom.

To clarify this point, consider the following example. Assume the current form of organization prevails. Suppose that Mr. B's physician is only one of many potential demanders (in different Medical Staff departments) for the use of the Operating Suite's ancillary services. The Operating Suite would of course have only a limited short-run preparedness to provide its ancillary services, due to constraints on the supply of such primary factors as operating room nurses, sterile equipment, etc. Mr. B's physician wants naturally to avoid a situation of short-run excess demand for operations just at the time when he may need to re-operate to stop Mr. B's bleeding. Since there are no internal prices, there is no simple mechanism for guaranteeing that the internal "market" in operating rooms will clear. In Mr. B's case, the possibility of disequilibrium in this market would be too costly. With other Medical Staff departments requiring operating rooms, it is not possible for his physician to issue a fiat to "hold an O.R. open for Mr. B in case I need it." In this type of situation, there will predictably be attempts to strike side-bargains to ensure the exclusive availability of the necessary services to one Medical Staff department.

This explains a phenomenon which is observed in some hospitals: the differentiation (and often reduplication) of Administration departments in order to create purely bilateral

transactions with specific Medical Staff Departments. In the case of newborn deliveries, for example, only physicians in the Medical Staff Department of Obstetrics and Gynecology use the ancillary services of the Delivery Suite, which is a department under the Administration. Except for a few pieces of specialized equipment (e.g., fetal monitors), there is in fact little technological distinction between the Delivery Suite and other surgically related departments. Yet a Delivery Suite is maintained separately solely to ensure the availability of factors of production for obstetricians' patients. Thus, one observes the phenomenon of obstetric hospital beds being used at less than full capacity at the same time that there are waiting lists for others. Similarly, a Cardiac Catheterization Department is available for use by Medical Staff members of the Department of Cardiology even though certain contrast-material studies available from Radiology are technically not very different. Further, some hospitals differentiate their own separate Medical and Surgical Intensive Care Units, yet the presence in other institutions of only a single intensive care unit suggests that this is not technologically required. These departmental proliferations are dictated by the need to create purely bilateral transactions in particular ancillary services. In these instances, it is easier to anticipate expected primary factor demands, provide the necessary services with correct timing, and thus reduce the

possibility of disastrous supply failure.[26]

One interpretation of this tendency toward bilateral transactions is that they eliminate the internal "markets" in ancillary services altogether. Although the supplying and demanding departments remain separate in order to preserve the physician's special status and property rights, they function in effect as a single decision unit. Outside of these decision units, there may be no transactions in the relevant ancillary service. In some hospitals, for instance, the Administration will appoint a physician from the demanding Medical Staff department as a "manager" of the supplying Administrative department. Even in these cases, the same rules governing property rights apply: the staff physicians do not pay for the primary factors; the Administration bills the patient for its ancillary service; and the physician bills separately. As a result, one observes dual appointments of the form "Staff Cardiologist and Clinical Director of the Cardiac Catheterization Laboratory". Despite the maintenance of a formal organizational separation between cardiologists and cardiac catheterization, the arrangement does ease the cardiologist's task of admitting and scheduling patients for this ancillary service.

Although these organizational adaptations have occurred only sporadically in some hospitals and for some ancillary services, it

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26. Although arguments can be offered that these departmental splits are purely on the basis of specialization of personnel or scale economies, these would be dubious at best. Hospitals often freely substitute personnel between departments. Also, even small hospitals may have, say, a separate delivery unit.

is possible that they could be generalized to all services in all hospitals. This possibility is predicated on a specific testable property of the technology of patient care, namely, its "decomposability". Even a cursory examination of the distribution of ancillary services in any hospital reveals that the majority of services are demanded almost exclusively to diagnose and treat a particular illness. Most brain scans are utilized by neurological cases; most skeletal xrays, orthopedic prostheses and specialized bed frames are used by orthopedic cases. Most hemodialysis is used for patients with chronic renal failure; most inhalation therapy is used for patients with respiratory diseases; and so forth. These technological relationships create a correspondence between certain upstream activities and certain downstream activities. Hence, they create the potential for a complete set of exclusively bilateral transactions between demanding Medical Staff departments and supplying Administration departments. If these departments could be appropriately "merged" into single decision units, then inter-departmental transactions in ancillary services-- and hence costly disequilibria in the intermediate commodity market-- would be minimized. Every department would not only control a subset of downstream activities (i.e., diagnosis and treatment of a group of illnesses) but also control the production of those ancillary services which are particular to that group of illnesses. The

resulting departmentalization of the firm would be on the basis of actual end-product sold rather than on the basis of global supply and local demand functions.

This reorganization is illustrated in Figure 2, which is Figure 1 repeated with some rearrangements in lines of jurisdiction. The new Neurology department treats neurological patients and controls the production of brain scans, computerized tomography, etc. The new Cardiology department controls Cardiac Catheterization. The pediatricians control the newborn nursery.

To formalize this idea, let D be a departmentalization and let x be an activity vector and recall that D imposes a partitioning on the coordinates of x into, say, K subsets, indexed by k. For each k=1 to K, construct a projection x^k by making each coordinate of x equal to 0 except for those coordinates which are in subset k. Then each x can be uniquely written as $x = \sum_{k=1}^{K} x^k$.

(vi) Definition: A departmentalization D is decomposable if and only if, for all feasible x, with $x = \sum_{k=1}^{K} x^k$, the corresponding projections x^k are all feasible.

Since the feasibility of each projection x^k requires that for all k, $y_I^k = 0$ (where $y^k = G(x^k)$), then every department in D cannot possibly produce a feasible x^k on its own unless it conducts both the necessary final and intermediate commodities. Hence, every element of the partitioning must contain coordinates from

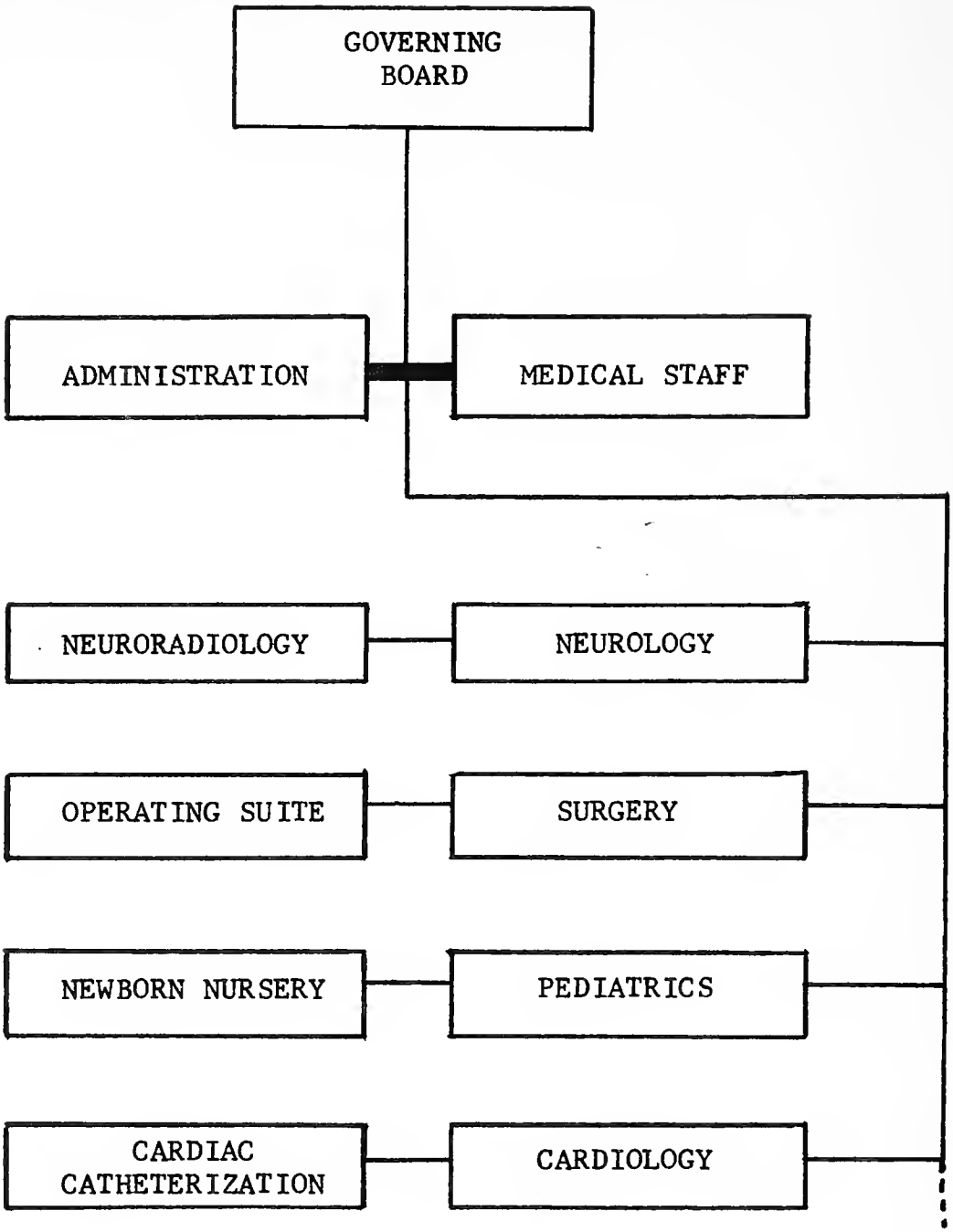
GOVERNING BOARD
ADMINISTRATION
MEDICAL STAFF
NEURORADIOLOGY
NEUROLOGY
OPERATING SUITE
SURGERY
NEWBORN NURSERY
PEDIATRICS
CARDIAC CATHETERIZATION
CARDIOLOGY

Figure 2

both x_U and x_D, a result which contradicts the institutional constraint (iii).

Complete decomposability would theoretically permit the reorganization of the firm into independent departments and thus eliminate the need for interdepartmental transfers of ancillary services. But the existence of this ideal property of production does not in itself constitute a creditable blueprint for reorganizing hospital care. Several questions need to be addressed: (1) Is decomposability an empirically accurate approximation of the technology of hospital care? (2) Even if a reorganization along product lines is technically possible, is it consistent with a simple allocational scheme which guarantees efficiency? (3) Reorganization would require that current clinical and managerial decisions be made in the same department. Doesn't this violate the current organizational separation embodied in constraint (iii) above? What then are the implied institutional changes in the relations between physician and hospital and can they be accomplished?

Empirical Example: The assertion that the technology of hospital care reasonably approximates decomposability is admittedly speculative. Data necessary to test this possibility are not available generally. An empirical example has been therefore constructed for a single hospital which, it is argued, can be

generalized to most firms.

A linear version of the model $y = G(x)$ was estimated for a single 300-bed metropolitan teaching hospital (see Harris [11]). For simplicity of specification, a world of nonjoint, unique production was assumed. That is, each unit of downstream basic activity x_{Di} was assumed to yield one case of a specific treated illness y_{Fi} and each unit of upstream activity x_{Uj} was assumed to yield one unit of a specific ancillary service y_{Ij} (so that y_F and x_D have the same dimensions and similarly for y_I and x_U). A Leontief-type, fixed-coefficients production function was assumed, so that the technology could be specified in terms of input requirement coefficients for the various activities. Now let $y_I = -x_D A$ describe the ancillary service requirements created by downstream activities, where the elements of A are non-negative. Thus, a_{ji} is the unit input requirement of service i for downstream activity j. By construction, the net output of ancillary services can therefore be written as $y_I = x_U - x_D A$. Similarly, by construction, the net output of y_F can be written as $y_F = x_D$. It is straightforward to show that if there exists a decomposable D, then the matrix A must be block diagonal. If this is true, then the rows and columns of A can be partitioned into blocks A_{kl} such that $A_{kl} = 0$ for $k \neq l$. Since a partitioning of the columns of A is correspondingly a partitioning of x_D, and since a partitioning of the rows of A

is correspondingly a partitioning of y_I or x_U, then the desired departmentalization is achieved by matching subsets of coordinates of x_U and x_D which correspond to the diagonal blocks of A.

Figure 3 is a representation of the estimated coefficient matrix A. Each row is labelled according to the corresponding ancillary service input. For visual simplicity, columns are labelled in groups, indexed by roman numerals. The individual components of each subset (identified left to right) are shown separately in the accompanying table. The matrix itself has been normalized so that only coefficients of significant magnitude are seen. Each element a_{ji} was divided by its row sum and the result indicated by an "X" if greater than 5 per cent, by a "." if greater than 2.5%, and left blank otherwise.[27] "X" was assumed to represent a major interaction and "." was appended to show minor but possibly significant inputs requirements.[28] Line segments have been drawn around the resulting blocks in the array to indicate the corresponding partitioning of activities.

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27. Since there were 68 columns in A, a uniform distribution of a particular ancillary service over all illnesses would imply that each input coefficient equal 1/68 or approximately .015. A significant interaction (i.e., an "X"), for example was 10.5 electrocardiograms for the average acute uncomplicated heart attack. A minor interaction (".") would be 3.3 electrocardiograms per case of pulmonary embolism (blood clot in the lung).

28. Actually, many of the coefficients labelled "." were less than their standard errors, but were nevertheless included in the Figure.

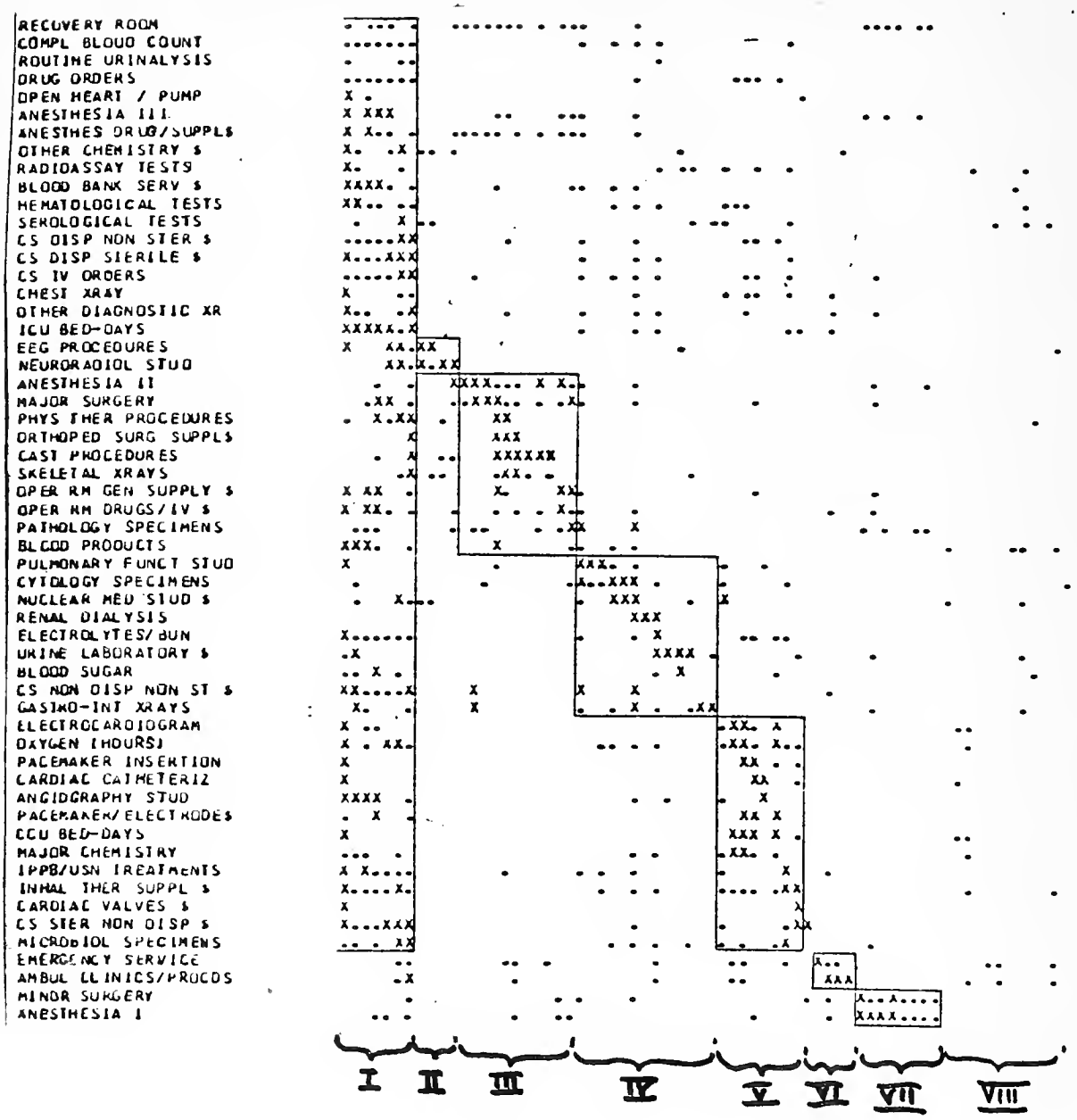
RECOVERY ROOM
COMPL BLOOD COUNT
ROUTINE URINALYSIS
DRUG ORDERS
OPEN HEART / PUMP
ANESTHESIA III
ANESTHES DRUG/SUPPLS
OTHER CHEMISTRY $
RADIOASSAY TESTS
BLOOD BANK SERV $
HEMATOLOGICAL TESTS
SEROLOGICAL TESTS
CS DISP NON STER $
CS DISP STERILE $
CS IV ORDERS
CHEST XRAY
OTHER DIAGNOSTIC XR
ICU BED-DAYS
EEG PROCEDURES
NEURORADIOL STUD
ANESTHESIA II
MAJOR SURGERY
PHYS THER PROCEDURES
ORTHOPED SURG SUPPLS
CAST PROCEDURES
SKELETAL XRAYS
OPER RM GEN SUPPLY $
OPER RM DRUGS/IV $
PATHOLOGY SPECIMENS
BLOOD PRODUCTS
PULMONARY FUNCT STUD
CYTOLOGY SPECIMENS
NUCLEAR MED STUD $
RENAL DIALYSIS
ELECTROLYTES/BUN
URINE LABORATORY $
BLOOD SUGAR
CS NON DISP NON ST $
GASTRO-INT XRAYS
ELECTROCARDIOGRAM
OXYGEN (HOURS)
PACEMAKER INSERTION
CARDIAC CATHETERIZ
ANGIOGRAPHY STUD
PACEMAKER/ELECTRODES
CCU BED-DAYS
MAJOR CHEMISTRY
IPPB/USN TREATMENTS
INHAL THER SUPPL $
CARDIAC VALVES $
CS STER NON DISP $
MICROBIOL SPECIMENS
EMERGENCY SERVICE
AMBUL CLINICS/PROCDS
MINOR SURGERY
ANESTHESIA I
I
II
III
IV
V
VI
VII
VIII

Figure 3

Table Accompanying Figure 3

I. Open Heart Surgery; Major Gastro-intestinal Srugery with Complications; Abdominal Aortic Aneurysm and Other Major Vascular Surgery; Major Vascular Surgery complicated by Severe Infection; Major Strokes and Intracranial Bleeding; Complex Back Surgery; Major Multisystem Trauma.

II. Uncomplicated Neurological Cases; Neurological Cases with Complications; Low Back Pain Syndromes; Ruptured Disc

III. Hernia Repair; Uncomplicated Major Abdominal Surgery; Gynecological Surgery; Orthopedic Surgery Uncomplicated; Pelvic or Femoral Fracture; Open Reduction of Fracture; Simple Orthopedic Cases, including Non-Surgical; Repair of Knee Dislocation; Trauma involving Two Organ Systems; Prostatectomy; Radical Mastectomy.

IV. Malignancy requiring Major Surgical Intervention; Respiratory Problem, Single, Uncomplicated; Respiratory Problems, Multiple; Malignancy with Metastatic Disease; Malignancy with Other Non-Surgical Complications; Malignancy with both Surgical and Non-surgical Complications; Renal Dialysis only; Renal Disease; Non-Surgical Vascular Disease; Diabetes; Other Multi-problem Medical; Single Problem Gastrointestinal Illness; Multiproblem Gastrointestinal Illness.

V. Pulmonary Embolism; Uncomplicated Heart Attack; Complicated Heart Attack (Shock or Heart Block); Pacemaker Insertion or Repair; Cardiac Catheterization Admission; Advanced Class III Cardiac Disease; Major Respiratory Infections; Acute Fatal Heart Attacks.

VI. Emergency Eye Service; Other Emergency Services; Simple Surgical Trauma; Drug Overdoses; Outpatient Visits.

VII. Abortions and D&C; Simple Urological Procedures; Breast Biopsy; Oral Surgery; Superficial Plastic Surgery; Simple ENT Procedures; Other Minor Gynecological Surgery; Routine Cystoscopy.

VIII. Malignancy Chemotherapy Uncomplicated; Evaluation of Heart Disease Class I; Evaluation of Heart Disease Class II; Thrombophlebitis; Non-surgical Gynecological Disease (Pelvic Inflammatory); Simple Trauma; Admission for Transfusions; Admission for Hematological Diagnosis; Stasis Ulcers; Simple Other Medical; Acute Terminal Care; Private Ambulatory Visits.

As the array indicates, the matrix does not conform completely to block diagonality. The seven left-most columns (group I), which represent the major medical and surgical "intensive care" cases, show significant input requirements for almost all ancillary services. Also, the absence of an "X" in the top rows (RECOVERY ROOM to DRUGS) means that some ancillary services were not specific to a particular group of illnesses. The absence of an "X" in the right-most group (VIII) indicates that these cases had generally little in the way of significant ancillary service input requirements. Despite these aberrations, it appears reasonable that a decomposable organization could be devised from the data of Figure 3. In order to procure ancillary service inputs for the cases of group I, it would be reasonable to reduplicate all of the ancillary services indicated. In effect, this group of the most serious illnesses would become a separate division of the firm. Since these are the catastrophic illnesses which most demand precision timing and which absorb a significant fraction of the firm's resources,[29] it would not be unreasonable to provide them separate access to the hospital's inputs.

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29. They represented 6.7% of the inpatient diagnoses and 20% of the total costs of the firm. The respective average costs per admission (in 1973 $) and percent of inpatient sample were: Open Heart $6435, 1.1%; Complicated Major Gastrointestinal Surgery $ 4158, 1.7%; Major Vascular Surgical Procedures such as Aortic Abdominal Aneurysm Repair $3658, 0.4%; Major Amputations Complicated by Infection $6470, 0.8%; Complex Vertebral Surgery $3171, 1.1%; Major Debilitating Strokes and Cerebral Hemorrhages $7579, 1.0%; and Complex Multisystem Trauma $6538, 0.6%. The average cost for an admission was $1844.

In addition to an Intensive Care department, the figure suggests six additional departments organized on product lines, corresponding to the six diagonal blocks. These include:(II) a Neurosystems Department, treating nonsurgical neurological cases and managing neurodiagnostic procedures such as electroencephalograms; (III) a Major Surgical Department, including major surgery of abdominal, gynecological, orthopedic and trauma, and managing the operating room, anesthesia, orthopedic supplies and procedures, with its own blood bank and pathological department; (IV) a General Medical Department, treating in particular malignancies, diabetes, renal disease and managing its own chemistry laboratory, renal dialysis, etc.; (V) a Cardiac-Respiratory Department, treating heart disease, heart attacks and major respiratory problems such as pneumonia and pulmonary embolism and managing the cardiac catheterization laboratory, electrocardiology, the pacemaker laboratory, a coronary care unit, and with its own inhalation therapy; (VI) an emergency care and ambulatory care department; and (VII) a Minor Surgery department treating minor biopsies, which would have its own surgical operating suites and anesthesia. As to those illnesses which generally do not command significant inputs of any types (the right-most columns), it would be reasonable to assign them ad hoc to other departments based on conventional clinical criteria.

Despite these assignments, the reorganization proposed in Figure 3 would still not be completely decomposable. As the figure indicates, there are some ancillary services which are so general in their application to all illnesses that it would be difficult to assign them to a particular Medical Staff department. It may be feasible in these cases to reduplicate these services for each department (e.g., each surgically oriented service would have its own recovery room; or the emergency room might have its own clinical laboratory and pharmacy), these arrangements might fragment existing Administration departments to the point of violating technological economies of scale. In the final analysis, it may be necessary to keep such departments as a general clinical laboratory (providing complete blood counts and urinalyses) and pharmacy separate in the organization.

In addition to these exceptions, there is also the more basic problem that the reorganization suggested here is only approximately decomposable. Although off-diagonal interactions may be small, they may not always be insignificant. For example, pathology services would be managed by the major surgical department (III), since most pathological specimens originate in major surgical procedures. The figure indicates, however, that certain cases of cancer managed by the general medicine service (IV) do have significant input coefficients for pathological services.

Internal Resource Allocation: Despite these empirical

exceptions, the proposed reorganization could represent a sufficiently close approximation to decomposability to have significant efficiency advantages for the firm. Internal organization along product (rather than functional) lines would tend to eliminate unnecessary interdepartmental transactions in ancillary services and hence obviate the need for internal prices in these commodities. The task of precision supply of ancillary service inputs would be eased considerably if the necessary goods need be supplied only to one demander.

In the ideal case in which there are no internal markets for ancillary services, each department could behave as an independent "profit center". Assume the existence of a short-run primary commodity constraint $\bar{y}_P$ as in definition (iv). Consider any efficient activity vector x with $y = G(x)$. Since G has the usual continuity and convexity properties, there exists a (column) price vector of final commodities w_F such that x maximizes $y_F w_F$ such that $y_P \geq \bar{y}_P$ and $y_I = 0$. Now consider the departmental assignments x^k, such that $\sum_{k=1}^{K} x^k = x$, and the resulting departmental outputs $y^k = G(x^k)$. Suppose that each department is allocated a short-run supply of primary commodities equal to y_P^k. Then it should be clear than each x^k is individually a profit maximizing solution for each department. Given an allocation of primary factors among each department, efficiency can thus be achieved by

requiring that each department maximize profit. Since, by decomposability, $y_I^k = 0$ for all k, each department's profit maximizing solution can be achieved without any interdepartmental transactions in intermediate commodities.

In the absence of decomposability, the departmental assignments corresponding to a feasible x will not generally be feasible, that is $y_I^k \neq 0$. In order to allocate resources, some signals for the ancillary services y_I would be necessary. Fortunate it "pays" to come as close to decomposability as possible.[30] In the linear case, it can be shown that the absolute magnitude of these intermediate commodity quantity signals can be made as small as possible by suitably small choices of coefficients in the off-diagonal blocks of the coefficient matrix A (see Harris [11]). Although it may be necessary to permit interdepartmental transaction in intermediate commodities, minimizing the magnitude of these transactions will still ease the coordination task considerably.

In actual implementation of this proposal, therefore, not every department could be organized as an independent profit center, nor would any department be completely autonomous. For these particular departures from the ideal, the use of internal prices for ancillary services may be a limited practical solution. As discussed in part I, these signals could not be depended upon

30. This idea and the resulting theorem were motivated by the concept of "near decomposability" developed by Ando, Fisher and Simon [1].

generally to clear internal markets in ancillary services under uncertainty. However, they would at least be a means of accounting costs and promoting efficiency incentives. Provided the magnitude of interdepartmental transfers was small, transfer rpices might work on a limited basis. For example, since most of the patients who sustain cardiac arrests are already extremely ill, it would be reasonable to assign this function to an Intensive Care department of the firm. However, since many patients may become unpredictably ill (such as Mr. B's unexpected post-operative bleeding), there will be a nonzero interdepartmental demand for this service. Although an internal price could not be used by itself to "clear the market" for Code Calls, it would assist in the internal accounting of such transactions.

The Code Call example raises some other doubts about the validity of the proposed reorganization, namely, will it actually function under uncertainty. When Mr. B presented with a fever and cough, the diagnosis of cancer was not established. If Mr. B were admitted to the reorganized firm illustrated in Figure 3, it is not obvious a priori that his case would be undertaken by a department treating malignancies. And when surgical removal of the tumor was contemplated, a surgeon from another department might have to be consulted.

Although uncertainty creates difficulties for once-and-for-all assignments of patients to particular departments, adapt-

ations would not be impossible in principle. In many cases, sufficient information is available to make a correct provisional assignment. When physicians' services in other departments are in fact needed, a transfer pricing system for consultations would be necessary.

If departments aligned on a product basis are to serve as profit centers, then prices based on final outputs will be necessary. However, as discussed in part I, there is the incentive problem that the firm would be motivated to announce the more expensive illness. Since hospital revenues will be paid mostly by third party insurers, it may be possible to monitor the output designations of the firm carefully enough to prevent cheating. If a profit center scheme of this type could be engineered, it would certainly obviate many of the inefficiencies present in the current system. Since pricing and net revenue considerations would be in terms of final goods, problems arising from the current system of marketing ancillary services would be eliminated. Efficiency of both stages of production would be induced. In particular, reimbursement contracts with insurers would be based upon case mix rather than service costs. This would be preferable as a means of comparing costs across institutions and thus serve as a basis for regulation of hospital costs. It would also avoid the perverse consequences which are characteristic of the reimbursement schemes based upon

the cost of ancillary services. The more efficient use of a particular intermediate input in the care of a particular illness would be regarded as a cost-saving rather than a revenue-losing device.

Physicians as Managers: Perhaps the most significant obstacles to implementation of the proposed reorganizatin are the implied changes in the role of physicians. The coexistence of physicians and managers in the same department would erode the institutional insulation which the physician has achieved. Profit maximization as a rule would require that the physician be accountable for the allocational consequences of his clinical decisions, and this would appear to violate the physician's professional immunity against economic considerations in clinical practice. Since there must also be some method to motivate departmental profit-maximizing choices, it would be logical to remunerate physicians in relation to the residual yielded by their departmental activities. The physician would, it appears, be like any other employee.

An interesting institutional solution to these problems--which follows the "dual appointment" practice discussed above--is to make physicians managers of their respective departments. Although the differentiation of local demand and global supply roles appeared to be a necessary means of decentralization in the

entire firm, the scale of operation within each department might be small enough to permit physicians to resume both functions. Each profit center, in effect, would be modelled as a specialized semi-autonomous group practice, marketing its own outputs, pricing its primary inputs and formulating wages according to contributions to the department's profits.

Although the imposition of a managerial role would mean restrictions on the physician's clinical choices, these would be only indirect. Economic rules about profit maximization or cost minimization are not the same as direct commands or interventions into professional practice. To be sure, even indirect constraints of this type would be viewed as an encroachment on the physician's ethical territory. But as a matter of speculation, it is not clear that physicians would resist these rules entirely. The current practice of avoiding economic considerations might yield to a view of medical decision-making in which the opportunity cost of an operation is as relevant to the decision as the potential results of the operation itself.

Finally, one might ask why physicians would even accede to these revisions. Again, as a matter of speculation, the proposed new roles for physicians might offer distinct advantages as compared to the existing form of private practice. A salary system based partly on contributed profit might have higher and more certain returns than private fee-for-service practice.

The Micro-analysis of Organizations: This discussion cannot presume to resolve all details of implementation or to respond to all potential objections. Clearly, the speculative nature of most of the argument makes empirical testing difficult. It should be clear however that a normative analysis of this type of firm could not have been performed "from the outside". Without a clear understanding of the nature of hospital production and clinical decision-making, it would be difficult to determine why the firm has chosen a particular form of organization, why certain operating rules are precluded and why certain output and regulatory conventions prevail. Without a micro-analytic view, the nature of the hospital's inefficiency and the possible means for remedying it would be obscure.

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